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Some Parasites and Diseases of Blue Whiting, *Micromesistius poutassou* (Risso), to the North and West of Scotland and at the Faroe Islands

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Some Parasites and Diseases of Blue Whiting, *Micromesistius poutassou* (Risso), to the North and West of Scotland and at the Faroe Islands

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Introduction

The stocks of blue whiting, *Micromesistius poutassou* (Risso), in the North-east Atlantic have been the subjects of increasing commercial interest in recent years. This interest helped to draw attention to a number of gaps in our knowledge of the biology of this species, one of which was the lack of information on its parasites and diseases. Work was therefore initiated, firstly to identify the more common parasites and diseased conditions of blue whiting and subsequently to select for special study those parasites which appeared likely to be pathogenic to the fish host, were of public health significance, or were of potential use as biological tags. This paper is concerned with the first of these objectives, *ie* to identify and comment briefly on the parasites and diseased conditions found.

Materials and Methods

Complete examinations of all host organs for fungal, protozoan and metazoan parasites and for diseased conditions were carried out on three samples of 24, 30 and 20 blue whiting caught by research vessels and preserved in 10% formalin. The earliest of these was taken in March 1962 off the west coast of Scotland and examined as part of a general unpublished survey of marine fish parasites under the supervision of Dr Z Kabata. The others were taken in April and November 1975 north of the Outer Hebrides and at Rockall respectively.

Three samples from commercial catches, totalling 308 blue whiting, were taken from two positions west of the Outer Hebrides and one near the Faroe Islands in April and May 1977 and examined fresh for selected parasites and diseases only. Two preserved samples of juvenile blue whiting, one of 55 O-group fish taken west of Shetland in September 1973, the other of 25 1-group fish taken at the northern edge of Faroe Bank in October 1975, and one preserved sample of 25 fish of mixed ages taken west of Shetland in October 1975, were also examined for selected parasites and diseases.

Sampling positions and dates are shown in Figure 1 and the results of examinations are shown in Table I.

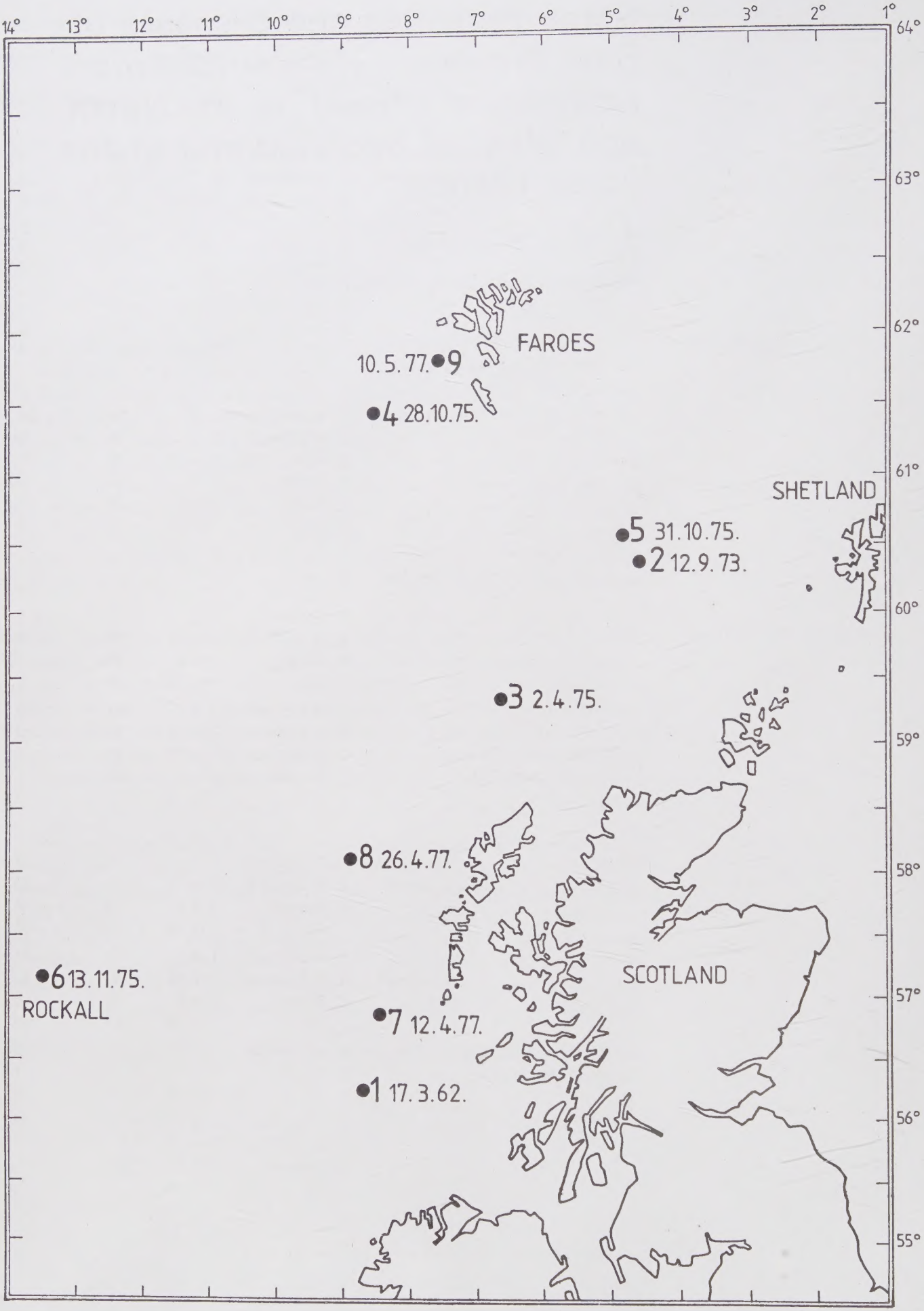

Figure 1. Chart of the study area, showing positions, reference numbers and dates of blue whiting samples.

Table I. Parasites and diseases found in blue whiting (See Figure 1 for sampling positions and dates)

Parasite or disease	Site of infection	Sample number and area	Age-group of fish	Number of fish	
				Examined	Infected
Fungi					
Ichthyophonus	Heart, liver kidney, spleen, muscle	1. W Scotland	1, 2	24	0
		2. N Scotland	0	55	0
		3. N Scotland	7 to 15	30	0
		4. Faroes	1	25	0
		5. N Scotland	1 to 15	25	0
		6. Rockall	3 to 8	20	3
		7. W Scotland	3 to 14	98	1
		8. W Scotland	3 to 13	101	0
		9. Faroes	3 to 17	109	0
		All	0 to 17	487	4
Protozoa					
Eimeria sp.	Liver	1. W Scotland	1, 2	24	21
		2. N Scotland	0	55	0
		3. N Scotland	7 to 15	30	27
		4. Faroes	1	25	0
		6. Rockall	3 to 8	20	19
		7. W Scotland	3 to 14	98	98
		8. W Scotland	3 to 13	101	101
		9. Faroes	3 to 17	109	109
		All	0 to 17	462	375
Zschokella hildae	Urinary ducts	1. W Scotland	1, 2	24	1
		3. N Scotland	7 to 15	30	4
		5. Rockall	3 to 8	20	1
		All	1 to 15	74	6
Pleistophora sp.	Hypaxial muscles	1. W Scotland	1, 2	24	0
		3. N Scotland	7 to 15	30	1
		5. N Scotland	1 to 15	25	1
		6. Rockall	3 to 8	20	1
		All	1 to 15	99	3
Nematoda					
Anisakis sp. larvae	Visceral cavity, muscle	1. W Scotland	1, 2	24	6
		3. N Scotland	7 to 15	30	30
		6. Rockall	3 to 8	20	19
		All	1 to 15	74	55
Thynnascaris adunca larvae and adults	Visceral cavity, stomach, intestine	1. W Scotland	1, 2	24	24
		3. N Scotland	7 to 15	30	30
		6. Rockall	3 to 8	20	15
		All	1 to 15	74	69
Contracaecum osculatum larvae	Liver surface	3. N Scotland	7 to 15	30	3
		6. Rockall	3 to 8	20	1
		All	3 to 15	50	4
Ascarophis morrhuae	Stomach	1. W Scotland	1, 2	24	1
		3. N Scotland	7 to 15	30	0
		6. Rockall	3 to 8	30	0
		All	1 to 15	74	1
Cestoda					
Diphyllobothrium sp. plerocercoids	Stomach and intestinal wall	2. N Scotland	0	55	0
		3. N Scotland	7 to 15	25	23
		4. Faroes	1	25	0
		5. N Scotland	1 to 15	25	11
		6. Rockall	3 to 8	20	3
		All	0 to 15	150	37

Table I. Parasites and diseases found in blue whiting *(continued)*

Parasite or disease	Site of infection	Sample number and area	Age-group of fish	Number of fish	
				Examined	Infected
Cestoda					
Grillotia sp. pleroceroid	Visceral cavity	1. W Scotland	1, 2	24	0
		3. N Scotland	7 to 15	30	1
		5. N Scotland	1 to 15	25	0
		6. Rockall	3 to 8	20	0
		All	1 to 15	99	1
Tetraphyllidean plerocercoids	intestine, pyloric caeca	1. W Scotland	1, 2	24	1
		3. N Scotland	7 to 15	30	9
		6. Rockall	3 to 8	20	10
		All	1 to 15	74	20
Monogenea					
Diclidophora minor	Gill filaments	1. W Scotland	1, 2	24	8
		3. N Scotland	7 to 15	30	14
		5. N Scotland	1 to 15	25	13
		6. Rockall	3 to 8	20	7
		All	1 to 15	99	42
Digenea					
Bucephaloides graciliscens metacercariae	Cranial cavity, spinal nerves	1. W Scotland	1, 2	24	24
		3. N Scotland	7 to 15	30	6
		5. N Scotland	1 to 15	25	8
		6. Rockall	3 to 8	20	12
		All	1 to 15	99	50
Hemiurus communis	Stomach	1. W Scotland	1, 2	24	0
		3. N Scotland	7 to 15	30	0
		6. Rockall	3 to 8	20	3
		All	1 to 15	74	3
Derogenes varicus	Gills, pyloric caeca	1. W Scotland	1, 2	24	1
		3. N Scotland	7 to 15	30	0
		6. Rockall	3 to 8	20	0
		All	1 to 15	74	1
Stephanochasmus sp.	Pyloric caeca, intestine	1. W Scotland	1, 2	24	2
		3. N Scotland	7 to 15	30	3
		6. Rockall	3 to 8	20	0
		All	1 to 15	74	5
Diseased conditions					
Gill cysts	Primary lamellae of gills	1. W Scotland	1, 2	24	3
		2. N Scotland	7 to 15	30	30
		6. Rockall	3 to 8	20	20
		All	1 to 15	24	0
Intestinal lesions	Intestine	1. W Scotland	1, 2	24	0
		3. N Scotland	7 to 15	30	8
		6. Rockall	3 to 8	20	0
		All	1 to 15	74	8

Results and Discussion

Fungi

Ichthyophonus

Ichthyophonus is the collective name for a fungus infection reported from many species of marine and freshwater fish. Most records are attributed to *Ichthyophonus hoferi* (Plehn & Mulsow), but it is not clear if this specific name embraces one or several species, so the collective generic name is preferred in the present instance.

The heart was the most common site of infection, but liver, kidney, spleen, swimbladder, gills and body muscles were also infected in different fish. Infected hearts were covered with a layer of tough nodular tissue, the nodules containing fungal spores. Infection of some fish species can result in death, and infected haddock are rendered unsaleable by their unsightly appearance and unpleasant smell (McVicar, 1977). There is no evidence that *Ichthyophonus* may be a serious pathogen of blue whiting.

Protozoa

Coccidia

Eimeria sp.

This parasite of the liver of blue whiting (Fig. 2) is remarkable in that it occurred in every one of the adult fish in samples 7, 8 and 9 but in none of the juvenile blue whiting examined in samples 2 and 4. Seven blue whiting in samples 1, 3 and 6 were recorded as uninfected but subsequent results have cast some doubt on the validity of these records. Low levels of infection, as measured by small numbers of oocysts in liver tissue smears, were picked up in later, more thorough examinations, but may have escaped detection in these earlier samples.

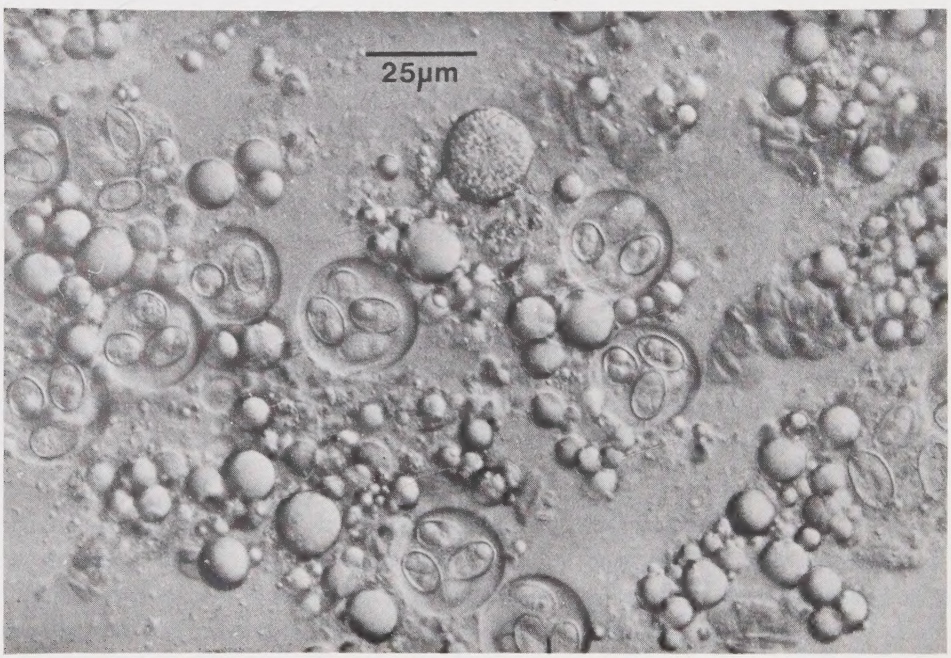

Figure 2. ***Eimeria*** **sp. oocysts in a fresh smear from a blue whiting liver.**

Eimeria sp. was selected for further investigation because of early indications of an inverse relationship between intensity of infection and host condition factor. MacKenzie (1978 and in press) confirmed this relationship and also showed that females were more heavily infected than males and that infection was cumulative with host age. Histopathology studies showed that heavy *Eimeria* infection results in extensive liver lesions (Fig. 3). The lesions appeared as clearly defined dark brown regions with hard outer capsules, within which the tissue was much softer than normal liver. Smears from lesions showed only small numbers of sporulated oocysts, but histological sections showed that at least half the volume of a lesion consisted of mostly empty *Eimeria* oocysts, giving the entire structure a spongy or honeycomb-like appearance. The conclusion drawn from this investigation was that

Eimeria infection is a major factor contributing to poor condition in blue whiting. Sindermann (1970) and Lom (1970) have reviewed the pathogenicity of coccidians of the genus *Eimeria* to fish hosts.

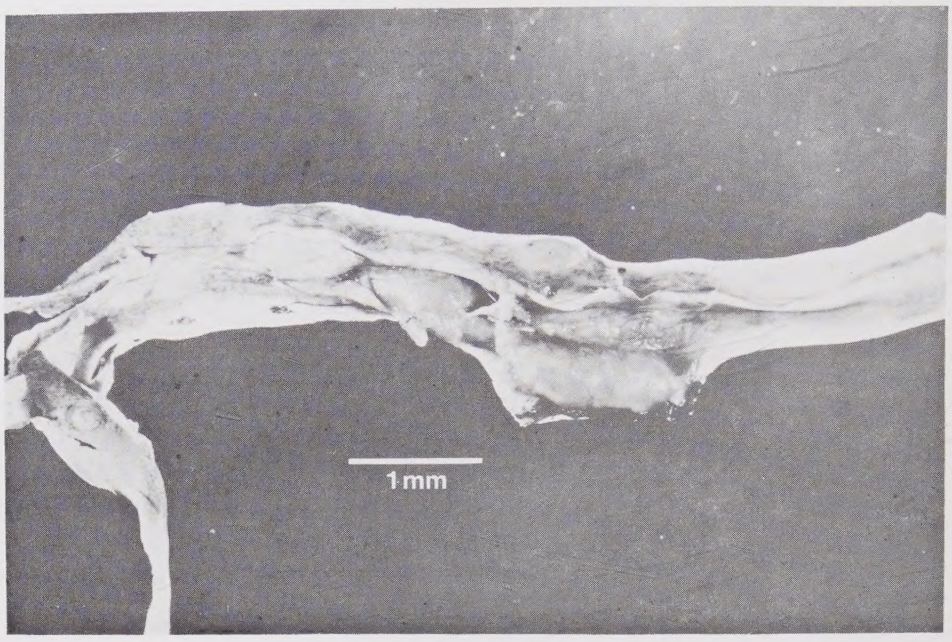

Figure 3. An extensive lesion in the liver of a blue whiting.

Morphologically, *Eimeria* sp. closely resembles *Eimeria clupearum* (Thelohan), parasitic in the liver of herring and other clupeoids, but the oocysts from blue whiting were consistently larger (20.5-29.5 μm diameter) than those reported from clupeoid hosts. Oocysts closely resembling those of *E. clupearum* were also commonly recorded from the livers of two species of small gadoids – the Norway pout, *Trisopterus esmarkii* (Nilsson), and the poor cod, *Trisopterus minutus* L. – taken in the same haul as the blue whiting in sample 6. It is not known whether one or more species of *Eimeria* are involved or if *E. clupearum* occurs in both clupeoid and gadoid hosts, but these records represent either one or more new species of *Eimeria* or three new host records for *E. clupearum.*

Myxosporida
Zschokkella hildae Auerbach

Spores were found in smears from the urinary ducts. This species was described from several gadoid host species off the west coast of Norway by Auerbach (1910), but has not previously been reported from blue whiting.

Microsporida
Pleistophora sp.

Elongate opaque white cysts which contained spores identified as belonging to a species of the genus *Pleistophora* (Fig. 4) were found in the hypaxial muscles. Dr R Wootten and Mr J Smith (personal communications) have reported seeing a number of blue whiting (particularly large fish) with *Pleistophora* cysts in the hypaxial muscles. Grabda (1978) reported microsporidan cysts, which were probably of this species, from blue whiting.

Nematoda
Ascaridida
Anisakis sp. larvae

Commonly known as 'herringworm', these nematodes are familiar parasites of many marine teleost fish and are particularly common in the visceral cavity and hypaxial muscles of blue whiting. As the adult worms are capable of infecting humans if ingested with uncooked fish, and since worms in the flesh reduce the market value of the fish, *Anisakis* sp. larvae in blue whiting have been the subject of intensive investigations by Wootten & Smith (1976) and Smith & Wootten (1978).

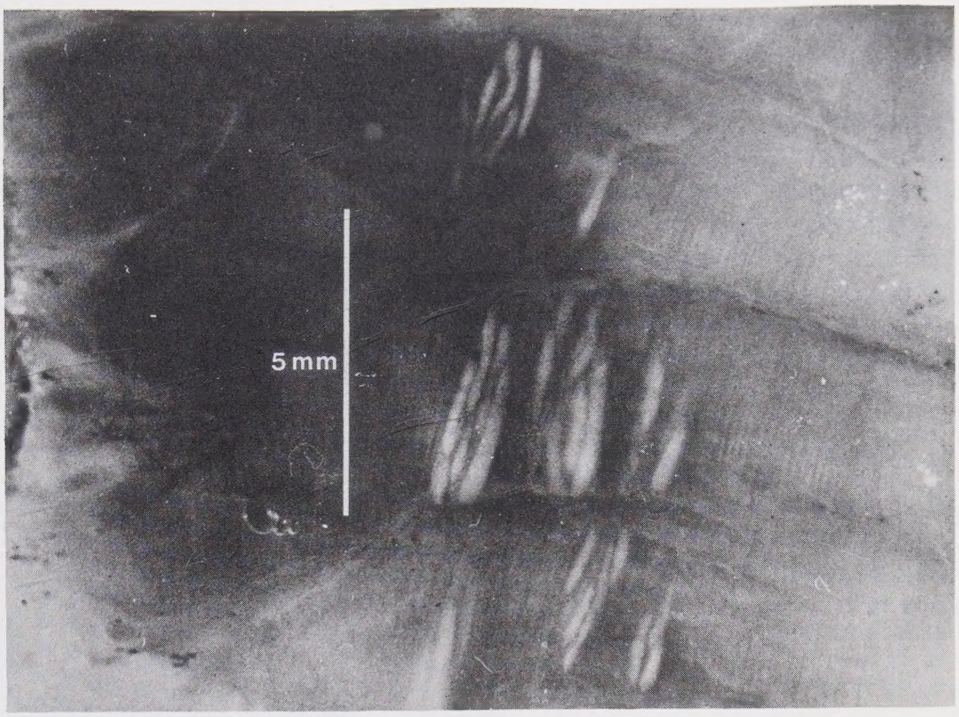

Figure 4. ***Pleistophora*** **sp. cysts in the hypaxial musculature of a blue whiting.**

This is one of the most widespread parasites of marine teleost fish.

Thynnascaris (= Contracaecum) adunca (Rudolphi) larvae and adults

Third-stage larvae were found in all parts of the visceral cavity, and fourth-stage larvae and adults in the stomach and intestine. Prevalence of infection was 75% at Rockall (sample 6), with a maximum of 52 worms per fish, and 100% in samples 1 and 3, with maxima of 49 and 138 worms per fish respectively. Adult blue whiting from samples 3 and 6 had larval infections of the visceral cavity only, whereas 1 and 2-group fish from sample 1 had adult and larval *T. adunca* in the alimentary tract as well as larvae in the visceral cavity. Differences in the diets of the fish in these samples may account for these differences in infection. Examination of the gut contents of blue whiting in samples 3 and 6 showed that the fish had been feeding mainly on euphausiid crustaceans. The fish in sample 1 may have acquired their infections of adult *T. adunca* through feeding on small fish infected with larvae.

Contracaecum sp. larvae

The four infected blue whiting each had one larva on the liver surface. These appeared identical to the larvae described by Berland (1961) from cod and lumpsucker, *Cyclopterus lumpus* L., and reported by Wootten (1978) from cod, haddock, whiting and poor cod. Adult worms of the genus *Contracaecum* are parasites of piscivorous birds and mammals. The larvae from blue whiting are very similar to *Contracaecum osculatum* Rudolphi, parasitic as an adult worm in seals.

Spirurida
Ascarophis morrhuae van Beneden

Two specimens were found in the stomach of one blue whiting. *A. morrhuae* has a wide host range in teleost fish (Yamaguti, 1961).

Cestoda
Pseudophyllidea
Diphyllobothrium sp. plerocercoids

Plerocercoids were found encysted in the stomach wall (Fig. 5) and on two occasions outside the intestine in adult blue whiting, but none was found in juvenile fish. Cysts are opaque white, spherical or slightly ovoid, and 2 to 4 mm in diameter. They are most conspicuous when the stomach is distended with food. Prevalence of infection was much higher in samples 3 (92%) and

5 (44%) from north of Scotland, than in sample 6 (15%) from Rockall. Grabda (1978) reported 28% prevalence of infection in blue whiting taken off North Ireland. This plerocercoid was described, but not specifically identified, by Andersen (1977) from material supplied by my colleague Mr J Smith and myself.

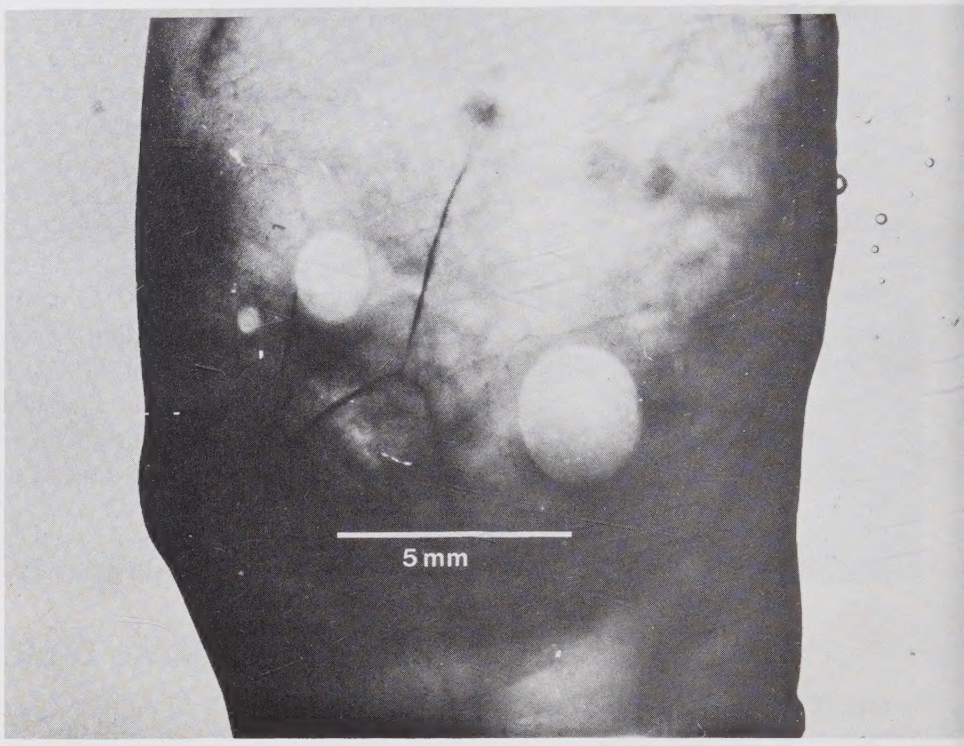

Figure 5. Encysted *Diphyllobothrium* sp. plerocercoids in the stomach wall of a blue whiting.

Diphyllobothrium sp. has some public health significance in that it may be infective to humans if ingested with uncooked blue whiting. Baer (1969) described human diphyllobothriasis in Peru resulting from the eating of a national dish called *cebiche* consisting of raw marine fish steeped in lime juic with peppers. The blue whiting parasite is unlikely to give rise to the same problem since the worm has not been found in the flesh and also because co sumption of uncooked fish is less favoured in Europe than in other parts of the world. Although *Diphyllobothrium* is well known as a parasite of European freshwater fish, this is the first example, according to Andersen (1977), of a *Diphyllobothrium* plerocercoid from a marine intermediate or transport host in the North Sea or North Atlantic. On ecological grounds, Andersen considered that the definitive host of the species from blue whitin is more likely to be a cetacean than a seal.

Trypanorhyncha
Grillotia sp. plerocercoid

A specimen was found encysted in the visceral cavity beside the pyloric caec in one blue whiting. Adult worms of this group parasitize the intestines of elasmobranch fish. Gaevskaya (1978) reported *Grillotia erinaceus* plerocerco from blue whiting.

Tetraphyllidea
Tetraphyllidean plerocercoids

From one to five specimens were found in the intestines and pyloric caeca. They were of the type found in the alimentary tracts of many marine teleos species and reported from blue whiting by Gaevskaya (1978) under the colle tive name *Scolex pleuronectis.* Adult tetraphyllideans are intestinal parasites of elasmobranch fish.

Monogenea
Diclidophoridae
Diclidophora minor (Olsson)

From one to 20 specimens of this monogenean, which is specific to blue whiting, were found on each infected fish.

The adhesive attitude of *D. minor* on the gills is identical to that described by Llewellyn (1956) for three other members of the genus *Diclidophora* on gadoid fish – *D. luscae, D. denticulata* and *D. phycidis.* All four species adhere to a single primary gill lamella, with the posterior adhesive organs nearer to the gill arch, and with the anterior end nearer to the distal end of the primary lamellae. Attachment of the clamps is to the inner (afferent) borders of the secondary gill lamellae. In order to chart the distribution of *D. minor* on the gills of blue whiting in samples 3, 5 and 6, each hemibranch was divided into dorsal, middle and ventral sections. Table II shows that most worms were found on the third gill arch of each side and that half of the total number were found on the middle sections. Llewellyn (1956) and Smith (1972) showed that *D. luscae* and *D. esmarkii* occurred most frequently on the second and third gill arches of the bib, *Trisopterus luscus* L., and the Norway pout respectively; Arme & Halton (1972) found that *D. merlangi* occurred most frequently on the first gill arch of whiting. *D. minor* seems to be more evenly distributed between the four gill arches than these other members of the genus *Diclidophora,* its distribution being closer to that of *D. luscae* and *D. esmarkii* than to that of *D. merlangi.*

Table II. Distribution of *Diclidophora minor* on the gills of blue whiting

	Section of gill arch						Totals	
	Dorsal		Middle		Ventral			
Gill arch	Anterior hemibranch	Posterior hemibranch	Anterior hemibranch	Posterior hemibranch	Anterior hemibranch	Posterior hemibranch	Samples 3 and 5 only	Including sample 1
Left 1	7	2	2	1	1		13	13
2	1	2	3	2			8	9
3	1	1	12	2		2	18	20
4		5				4	9	12
Right 1	1		2			1	4	6
2	2	1	3	1		1	8	8
3	3		8	2	1	6	20	20
4		3	1	10		4	18	19
Totals	29		49		20		98	107

Digenea
Bucephalidae
Bucephaloides graciliscens (Rudolphi) metacercariae

These common parasites of gadoid fish were found encysted in the cranial cavities and nerves of blue whiting in numbers ranging from one to 66 per fish. Metacercariae were also found in the spinal nerves near the tail in one fish from sample 1.

The relatively high prevalence of *B. graciliscens* at Rockall (60%) is particularly interesting when one considers that the bivalve mollusc *Abra alba* (Wood), which Matthews (1974) showed to be the first intermediate host of *B. graciliscens,* has not been found in benthos samples from Rockall (Dr A Eleftheriou, personal communication). According to Tebble (1966), *A. alba* may be found from extreme low-water mark to about 36 fathoms (65.8 metres), so that Rockall Bank would be well beyond its depth range. This means that the infected blue whiting at Rockall must have migrated there from a shallower coastal nursery area and suggests that *B. graciliscens* may prove to be useful as a biological tag for estimating the proportions of components of different origin in the blue whiting population at Rockall.

Hemiuridae
Hemiurus communis Odhner

Two specimens of this digenean were found in the stomachs of two blue whiting and four in another, all from the Rockall sample. It occurs in the adult stage in a wide range of teleost fish species (Dawes, 1947), and was reported from blue whiting from west of Cornwall by Bray (1973). Metacercariae of the genus *Hemiurus* have been reported free in the plankton and unencysted in planktonic copepods and chaetognaths (Pratt, 1897; Lebour, 1923, 1935; Meek, 1928; Rose, 1931). The specimens from blue whiting may have been acquired through eating fish previously infected with adult worms.

Derogenes varicus Muller

This parasite is found usually in the upper alimentary tract. One blue whiting was found to be parasitized with two specimens, one in the stomach and one on the gills. It occurs in the adult stage in a wide range of teleost species (Dawes, 1947) and was reported from blue whiting by Gaevskaya (1978). Progenetic metacercariae of *D. varicus* have been reported from chaetognaths (Scott, 1896; Lebour, 1917; Zaika & Kolesnikov, 1967; Reimer *et al.*, 1975), a polychaete (Levinsen, 1881), a planktonic copepod (Hall, 1929), a parasitic copepod (Dollfus, 1954) and hermit crabs (Uspenskaya, 1955). As with *H. communis*, infection of blue whiting may have resulted from eating fish previously infected with adult worms.

Acanthocolpidae
Stephanochasmus (= *Stephanostomum*) sp.

From one to four specimens were found in the pyloric caeca and upper intestine. No fish from Rockall was infected.

It was not possible to identify this species specifically because the oral spines, the number of which is an important diagnostic feature, were not present, possibly owing to the effect of formalin. This is a problem experienced previously with digeneans of this genus. From the diagnostic features which were visible it is certain that these specimens were either *Stephanochasmus caducus* Looss or *Stephanochasmus pristis* Looss. Both species are parasites of the intestines and pyloric caeca of gadoid fish and Gaevskaya (1977) reported *S.pristis* from blue whiting. This group of parasites usually have teleost fish as second intermediate hosts. Køie (1978) described the life cycle of *S. caducus* and showed that the first intermediate host is the mollusc *Natica alderi* Forbes and that the second intermediate hosts are gobies. Køie refuted suggestions that *S. caducus* and *S. pristis* may be conspecific.

Diseased Conditions of Unknown Etiology
Gill Cysts

These cysts (Fig. 6), measuring up to 1.3 mm in diameter, were seen on the primary lamellae of the gills of blue whiting, including all the adult fish from two samples. Up to 20 cysts were found on the lamellae of each gill arch. Each cyst consisted of an outer fibrous capsule containing parenchyma-like tissue in which was embedded a dense acellular opaque white body, roughly spherical in shape, apparently consisting of an accumulation of lipid material. Incipient cysts appeared on the primary lamellae as small swellings, each of which invariably had at its centre one of the white bodies. The size of this central body varied directly with that of the entire cyst. No parasites were found associated with the cysts.

Intestinal Lesions

These were all found in blue whiting from sample 3 taken north of the Outer Hebrides. The lesions were diptheritic, ie a tough light-coloured membrane covered the surface of the intestinal mucosa. Affected parts of the intestine were up to 2 cm long and in some the membrane completely encircled the intestinal lumen.

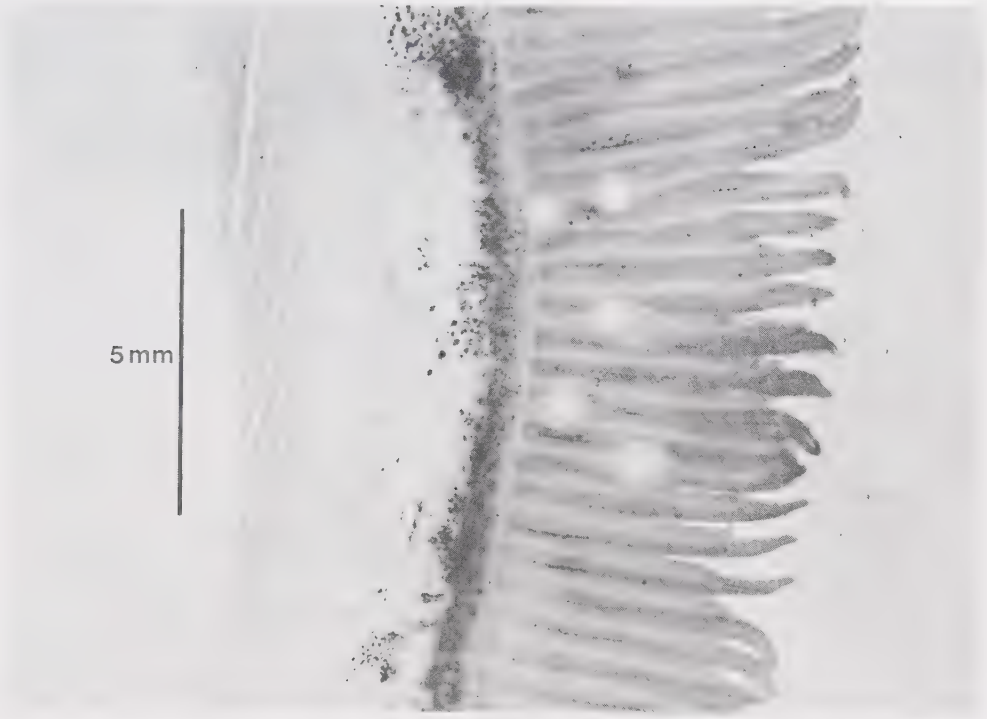

Figure 6. Cysts of unknown etiology on the gills of blue whiting.

Conclusions

The main conclusions, with reference to the objectives stated in the introduction to this report, are as follows.

Blue Whiting Pathogens

Eimeria sp. is a serious pathogen of blue whiting. The disease, known as coccidiosis, manifests itself through loss of condition and the formation of macroscopic lesions in the liver.

Public Health

The nematodes *Anisakis* sp. and *Thynnascaris* (=*Contracaecum*) *adunca* and the cestode *Diphyllobothrium* sp. are capable of infecting humans if ingested with uncooked blue whiting. However, only *Anisakis* sp. has been found in the flesh, and normal cooking methods eliminate the risk of infection with any of these parasites.

Biological Tags

The digenean *Bucephaloides graciliscens* could prove useful in identifying components of different origin in the blue whiting population at Rockall. Information on the parasite fauna of blue whiting from other parts of the host's geographical range may reveal other potentially useful tags amongst the parasites reported herein.

Acknowledgements

I wish to thank Mr J R Hutcheon for providing age data from blue whiting otolith readings, and Dr A L S Munro and Dr A D McIntyre for reading the manuscript.

Summary

Complete examinations of all organs for parasites and diseased conditions were carried out on three samples, totalling 74 adult blue whiting, *Micromesistius poutassou*, taken west of the Outer Hebrides and at Rockall. A further six samples, totalling 413 juvenile and adult blue whiting, taken to the north and west of Scotland and near the Faroe Islands, were examined for selected parasites and diseases. The following parasite species were found: *Ichthyophonus* (Fungi); *Eimeria* sp., *Zschokkella hildae, Pleistophora* sp. (Protozoa); *Anisakis* sp. larvae, *Thynnascaris* (= *Contracaecum*) *adunca* larvae,

Contracaecum sp. larvae, *Ascarophis morrhuae* (Nematoda); *Diphyllobothriu* sp. plerocercoids, *Grillotia* sp. plerocercoid, tetraphyllidean plerocercoids (Cestoda); *Diclidophora minor* (Monogenea); *Bucephaloides graciliscens* metacercariae, *Hemiurus communis, Derogenes varicus, Stephanochasmus* (= *Stephanostomum*) sp. (Digenea). Gill cysts and diphtheritic intestinal lesions of unknown etiology were also found.

Eimeria sp. causes coccidiosis of the liver in blue whiting. Symptoms of the disease are loss of condition and the formation of macroscopic lesions in the liver. *Bucephaloides graciliscens* could prove useful as a biological tag for identifying different components in the blue whiting population at Rockall.

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